(19) JAPANESE PATENT OFFICE (JP)

(12) PATENT JOURNAL (A)

(11) KOKAI PATENT APPLICATION NO. HEI 2 [1990]-23623

(43) Publication Date: January 25, 1990

(54) ELECTRODE FORMATION METHOD

(72) Inventor: Koji Matsubara
Sharp K.K.
22-22 Nagaike-cho
Abeno-ku, Osaka-shi
Osaka-fu

(72) Inventor: Yasunobu Tagusa
Sharp K.K.
22-22 Nagaike-cho
Abeno-ku, Osaka-shi
Osaka-fu

(72) Inventor: Takashi Kinui
Sharp K.K.
22-22 Nagaike-cho
Abeno-ku, Osaka-shi
Osaka-fu

(71) Applicant: Sharp K.K.
22-22 Nagaike-cho
Abeno-ku, Osaka-shi, Osaka-fu

(51) Int. Cl.^{5}: H 01 L 21/321
C 09 J 5/00
H 01 L 21/60
23/15
H 05 K 3/24
3/32
H 01 L 21/92
23/14

Patent Office File Nos.: 6824-5F
7738-5F
6944-4J
6918-5F
6736-5E
6736-5E

(21) Application No.: Sho 63 [1988]-174218

(22) Application Date: July 12, 1988

No. of Claims: 1 (Total of 8 pages)
Examination Request: Not requested

(74) Agent: Keiichiro Nishitaka, patent attorney, and one other

[There are no amendments to this patent.]

CLAIM

Electrode formation method, characterized by including a process during which an adhesive layer is formed over the main body of an electrode formed on an object in advance and

a process during which conductive particles having partially or fully conductive surface are adhered to said adhesive layer where said adhesive layer has tackiness in such a way that they protrude from the adhesive layer.

DETAILED EXPLANATION OF THE INVENTION

INDUSTRIAL FIELD OF THE APPLICATION

The present invention pertains to an electrode formation method suitable for the formation of electrodes for electrical connection of a circuit board, on which a semiconductor element is formed, with a circuit board, such as a printed board and a ceramic substrate, for example.

PRIOR ART

Conventionally, when connecting a circuit board on which a semiconductor element is formed with another circuit board, such as a printed board, a flexible substrate, and a ceramic substrate, electrodes (will be referred to as bump electrode, hereinafter) were formed to protrude from the circuit board on which a semiconductor element is formed in order to connect electrically via said bump electrodes the circuit board on which a semiconductor element with the aforementioned circuit board of the other kind. Formation of this kind of bump electrode is achieved by means of a plating method, a vapor deposition method, or a transfer method.

The plating method refers to a method in which bump electrodes are formed on the main bodies of the electrodes by means of electroplating. In the plating method, if a lift-off method is utilized, for example, a lift-off resist is formed, a barrier metal layer is formed over the entire surface thereof to prevent metallic diffusion, and electroplating must be carried out after the resist masking is applied to the portions where plating is not needed. Thus, this kind of plating method had a problem that its operation process became unnecessarily complicated.

The vapor deposition method refers to a method in which a metallic mask having through holes created at the positions where bump electrodes are to be formed is placed on a circuit board, a metallic layer is formed under the condition by means of sputtering or electron beam vapor deposition, and the metal is used to form bump electrodes. In this vapor deposition method, it was necessary to vapor-deposit a metal used for the construction of bump electrodes via the metallic mask again after a barrier metal layer was formed. Therefore, not only the operation process became complicated, but also much materials was needed, and a precision metallic mask had to be created, resulting in an increase in terms of the cost.

In addition, in the transfer method, protrusions are created at specific positions on a temporary substrate by means of plating with gold, for example, and the temporary substrate is layered over a circuit board on which bump electrodes are to be formed and heated. As a result, the protrusions made of gold are thermally transferred onto the aforementioned circuit board to form bump electrodes.

In the case of this kind of transfer method, no metals other than gold can be used as the material for the protrusions. Therefore, an increase in cost will result. What is more, because the gold plating and the thermal transfer are subject to rigorous conditions, there is a problem that it is difficult to form bump electrodes with the desired shape.

Furthermore, all the aforementioned bump electrode formation methods intend to achieve alloy connection of the circuit board on which bump electrodes are to be formed with another circuit board. Therefore, for example, when bump electrodes are made of gold, the electrode material on the other circuit board to be connected with said gold must have affinity with gold. Thus, there is a disadvantage in that electrode material for the other circuit board is subject to restrictions. In addition, because the alloy connection is involved, there is a problem of poor connection due to the difference in the thermal expansion rates between the circuit boards to be connected.

The pressure welding method refers to a method used for electrical connection between the aforementioned protruding electrodes and the electrodes formed on the other circuit board by means of pressure welding. It has advantages in that the material of the electrode on the other circuit board described above is not only not subject to any restrictions, but also the aforementioned poor connection can be prevented, and highly reliable connection conditions can be maintained. However, connecting the bump electrodes using the pressure welding method has large practical problems in terms of precise height of the bump electrodes, flatness of the circuit boards to be connected, and strict connecting conditions. Thus, as disclosed in Japanese Kokai Patent Application No. Sho 61 [1986]-259548, a method is being considered in order to form elastic bump electrodes; wherein, a silicon rubber layer is formed on the main bodies of the bump electrodes, and a conductive layer is formed over the surface thereof.

In addition, as disclosed in Japanese Kokai Patent Application No. Sho 63[1988]-47943, a method is being considered in which after microcapsules are provided only over the connecting electrodes on the circuit board on the one side, and [the board] is aligned with the other circuit board, [the boards] are thermocompressed to be bonded to each other.

PROBLEMS TO BE SOLVED BY THE INVENTION

In the aforementioned method for the formation of the aforementioned elastic bump electrodes, a photoresist coating process and a masked exposure process are needed at least twice during the formation of the silicon rubber layer over the main bodies of the electrodes and during the formation of the conductive layer. In addition, problems such as the issue of the adhesiveness between the silicon rubber layer and the conductive layer remain yet to be solved,

In the case of the method utilizing microcapsules, because the bonding is achieved by means of thermocompression, when a substrate containing a liquid crystal display part having little tolerance against heat is utilized for the circuit board on the one side, for example, there are problems yet to be solved of sufficient connection due to the heat and low reliability resulting from the fact that the connections are made only at the parts where electrodes are formed.

The purpose of the present invention is to present a method for the formation of the bump electrodes for making connections by means of the pressure welding method easily, inexpensively, and highly reliably using a simple method in order to solve the aforementioned technical problems.

MEANS TO SOLVE THE PROBLEMS

The present invention is an electrode formation method characterized by including a process during which an adhesive layer is formed over the main body of an electrode formed on an object in advance and

a process during which conductive particles having partially or fully conductive surface are adhered onto said adhesive layer while said adhesive layer has tackiness in such a way that they protrude from the adhesive layer.

FUNCTION

According to the present invention, the main bodies of the electrodes are formed on the object in advance, and the adhesive layer is formed over the main bodies of the electrodes. Subsequently, conductive particles are adhered to the adhesive layer while the adhesive layer has

tackiness, and portions of the conductive particles form protrusions from the aforementioned adhesive layer. As a result, bump electrodes are formed.

Therefore, when mounting a semiconductor device onto the circuit board, for example, if the aforementioned bump electrodes are formed on said semiconductor device, the semiconductor device can be bonded highly reliably board onto the aforementioned circuit by means of pressure welding.

In addition, when performing pressure welding using the aforementioned bump electrodes, a thermosetting or a natural-setting adhesive may be used for bonding the circuit boards together in order to achieve bonding over a wide area at a low temperature. Also, because the electrical junctions are sealed by a resin, connections can be attained at even higher reliability.

APPLICATION EXAMPLES

Figure 1 is a cross section showing the configuration of the semiconductor device (7) of an application example of the present invention. The semiconductor device (7) is configured with inclusion of a substrate (1) as an object made of silicon, a wiring layer (2) formed on said substrate (1) and serving as the main bodies of the electrodes, a nonconductive adhesive layer (8), and conductive particles (5). The wiring layer (2) is formed selectively on one side of the substrate (1). In general, said wiring layer (2) is made of aluminum. However, 1, 2, or more layers may be coated using a metal, such as Au, Ag, Pd, Ni, Cu, Cr, Ti, W, Zn, Su, Pb, In, Mo, or Ta, or an alloy of theses metals may be used as the material in order to reduce the contact resistance.

A surface protection coating (3) is formed in the areas where the wiring layer (2) is not formed on the substrate (1). Said surface protection coating (3) is made of SiN, PSG (SiO_2), or polyimide.

The nonconductive adhesive layer (8) is formed as an upper layer on the semiconductor device (7) as shown in Figure 1. Said adhesive layer (8) is cured using a method to be described later under the condition in which the conductive particles (5) are kept in contact with the surface of the wiring layer (2) by the one end, and the other ends are protruding from the adhesive layer (8). Various kinds of synthetic resins, such as an acrylic resin, a polyester type resin, an urethane type resin, an epoxy type resin, or a silicon type resin, may be utilized for the adhesive layer (8). Also, a metal, such as Au, Ag, Cu, C, In, Pd, Ni, Pb, or Sn, or an alloy of theses metals may be used as the material for the conductive particles (5); wherein, the metal has a grain diameter of several μm to several 10s of μm. In addition, an elastic synthetic resin, such as silicon rubber and urethane rubber, coated with Au, Ni, or C, or elastic conductive particles

made of a material obtained by mixing a metal, such as Au, Ag, Cu, Ni, C, In, and Pd, or fine particles of an alloy of theses metals with the aforementioned elastic synthetic resin, can be used for the aforementioned conductive particles (5).

When connecting the semiconductor device (7) to the other wired substrate by means of pressure welding, the height of the bump electrodes is prevented from becoming uneven by making the grain diameter of the conductive particles (5) uniform, and an elastic material is used for the conductive particles (5) in order to improve the reliability of the connections.

Figure 2 shows cross sections to explain the production process of the configuration shown in Figure 1. As shown in Figure 2 (1), in the substrate on which the surface protection coating (3) and the wiring layer (2) have been formed in advance, an adhesive is coated over the entire surface of said the wiring layer (2) and the surface protection coating (3) in Figure 2 by means of spin coating or roll coating in order to form an adhesive layer (8a).

Said adhesive layer (8a) is light-curable. Thus, it is also possible to irradiate an appropriate amount of UV to cure the adhesive layer (8a) in stages in this condition, so that the viscosity is increased to an improved tackiness, in order to prevent the adhesive layer (8a) from leaking out and the conductive particles from diverging during the removal of unneeded conductive particles (5), to be described later. In addition, it is also possible that after an adhesive with a high viscosity is diluted using a solvent to an appropriate viscosity and applied using the aforementioned spin coating method or the roll coating method, the solvent is evaporated for curing in stages before the conductive particles (5) are adhered. Furthermore, it is also possible that when a thermosetting adhesive is used as the material for the adhesive layer (8a), after a low-viscosity adhesive is applied using the aforementioned method, heat is applied for curing in stages to increase the viscosity before the conductive particles (5) are adhered.

An UV ray is irradiated on the substrate (1) on which the adhesive layer (8a) has been formed, in the manner indicated by the arrows 20 in Figure 2 (2) via a mask (9). The mask (9) is provided with shielding parts (9a) to shield out the UV ray and through holes (9b) to let the UV ray pass; whereby, the through holes (9b) are aligned with the areas where the surface protection coating (3) is formed on the substrate (1) before the UV ray is irradiated. As a result, the adhesive layer (8b) in the areas where the surface protection coating (3) is formed gets cured. At this time, the adhesive layer (8a) in the areas where the wiring layer (2) is formed has tackiness. A narrow pattern of adhesive layer (8a) with tackiness can be formed in this manner.

After the narrow pattern of adhesive layer (8a) is formed, the conductive particles (5) are adhered. The condition then is shown in Figure 2 (3). The conductive particles (5) are adhered only to the portions where the adhesive layer (8a) with tackiness is formed, and unneeded conductive particles (5) attached to other areas due to static electricity are removed by means of air blow or using a brush. Therefore, the conductive particles (5) can be adhered selectively only

to the areas where the wiring layer (2) is formed. The bump electrodes are formed in this manner.

As the adhesive layer (8a) with tackiness is subsequently cured, handling the semiconductor device (7) becomes easier, and workability during the production process of the semiconductor device (7) becomes improved. In addition, as will be described later, when applying molding using an adhesive after this kind of semiconductor device (7) is connected to another circuit board, the aforementioned adhesive layer (8a) can be cured also through the same process as that of the molding adhesive.

Figure 3 is a cross section showing the configuration of the semiconductor device (6) of another application example of the present invention. Furthermore, the same symbols are used for the parts corresponding to those in the application example shown in Figure 1. In the case of the configuration shown in Figure 3, in a substrate (1) on which a wiring layer (2) and a surface protection film (3) have been formed, a conductive adhesive layer (4) is formed selectively only over the areas where the wiring layer (2) is formed by means of photolithographic etching. In this case, various kinds of synthetic resins, such as an acrylic resin, a polyester type resin, an urethane type resin, an epoxy type resin, and a silicon type resin, may be used as the material for the adhesive layer (4). Also, a light-setting, thermosetting, or natural-setting adhesive can be utilized.

If fine particles of conductive materials, such as Au, Ag, Cu, C, Pd, Ni, and In, or those of an alloy of the conductive materials are mixed as [sic; to] the adhesive layer (4) in order to add conductivity, and a light-setting or thermosetting material is used for the adhesive, the adhesive layer (4) can be cured after the conductive particles (5) are adhered, so that the workability during the production process of the semiconductor device (6) can be improved significantly. In addition, because the conductive particles (5) do not necessarily stay in contact with the wiring layer (2) by one edge, the production process can be simplified.

The semiconductor devices (6) and (7) provided with bump electrodes formed in the aforementioned manner are connected to a circuit board, such as a printed substrate, a flexible substrate, a ceramic substrate, or a glass substrate, while they are being pressed against the circuit board.

Figure 4 (1) is a cross section for explaining the condition under which the semiconductor device (6) is mounted onto a circuit board (12); Figure 4 (2) is a cross section showing an expanded view near the junction parts of Figure 4 (1). The circuit board (12) and the semiconductor devices (6) are connected while they are being pressed against each other by means of a clip (11). Accordingly, the semiconductor devices (6) is mounted onto the circuit board (12).

The surface of the semiconductor device (6) where the bump electrodes are formed by means of the aforementioned production method and the surface of the circuit board where electrodes (13) are formed are aligned at the positions at which the conductive particles (5) and the electrodes (13) come in contact by means of the clip (11), for example, and pressed against each other while they are being placed to face each other using guide (10). In this manner, the wiring layer (2) of the semiconductor device (6) and the electrodes (13) of the circuit board (12) are connected electrically via the conductive particles (5), and the semiconductor device (6) is now mounted on the circuit board (12).

Figure 5 (1) is a cross section for explaining another condition under which the semiconductor device (6) is connected to the circuit board (12); and Figure 5 (2) is a cross section showing an expanded view near the junction parts of Figure 5 (1). In the method shown in Figure 5, the surface of the semiconductor device (6) where the bump electrodes are formed and the surface of the circuit board (12) where the electrodes (13) are formed are placed to face each other and positioned in such a way that the conductive particles (5) and the electrodes (13) come in contact, and the semiconductor device (6) is pressed against the circuit board (12) via an adhesive layer (14). In this condition, the adhesive layer (14) is cured in order to mount the semiconductor device (6) onto the circuit board (12).

Although mounting of the semiconductor device (6) onto the circuit board (12) was explained using Figure 4 and Figure 5, the semiconductor device (7) shown in Figure 1 can also be mounted onto the circuit board in the same manner. In addition, a light-setting, thermosetting, or natural-setting adhesive can be utilized as the material for the adhesive layer (14) shown in Figure 5. In particular, when a light-setting adhesive is utilized, as it was described previously, it can be cured through the same processes as those for the curing of the adhesive layers (8a) and (4) explained in Figure 1 and Figure 3. Thus, those processes can be omitted.

In the present invention, bumps electrodes can be formed easily on a semiconductor device through simple processes as described above. Therefore, bump electrodes can be formed on a semiconductor device easily and inexpensively. In addition, because the bump electrodes formed in the manner can made into a uniform height easily through the utilization of conductive particles with uniform grain diameter, the semiconductor device having this kind of bump electrode can be mounted quickly onto the circuit board (12) by means of pressure welding. In the present method, because the semiconductor device is mounted onto the circuit board by means of pressure welding, connecting reliability is not affected by the materials for the electrodes on the circuit board, and a highly reliable connection can be achieved.

Furthermore, if conductive particles (5) with elasticity were utilized, for example, said conductive particles are able to form different shapes in order to follow any warp or winding of the substrate, so that connecting reliability can be improved further.

Although the cases in which bump electrodes are formed on a substrate (1) to be used for a semiconductor device were explained in the present application examples, [the present invention] is not necessarily limited to the case in which electrodes are formed in relation to a semiconductor device. For example, the present invention may also be utilized when forming electrodes on other circuit boards.

EFFECT OF THE INVENTION

As it has been explained above, with the present invention, bump electrodes can be formed on the surface of an object through an extremely easy method. Thus, when connecting a substrate on which said electrodes are formed with another substrate by means of pressure welding, for example, a highly reliable connection can be achieved. Therefore, productivity can be improved, and the cost can be reduced.

BRIEF EXPLANATION OF THE DRAWING

Figure 1 is a cross section showing the configuration of the semiconductor device (7) of an application example of the present invention; Figure 2 shows cross sections to explain the production process of the configuration shown in Figure 1; Figure 3 is a cross section showing the configuration of the semiconductor device (6) of another application example of the present invention; Figure 4 shows cross sections to explain the condition under which the semiconductor devices (6) is mounted onto the circuit board (12); and Figure 5 shows cross sections to explain another condition under which the semiconductor device (6) is mounted onto the circuit board (12).

1 ... substrate; 2 ... wiring layer; 3 ... surface protection coating; 4, 8, 14 ... adhesive layer; 5 ... conductive particle; 6, 7 ... semiconductor device; 10 ... guide; 11 ... clip; 12 ... circuit board; and 13 ... electrode.

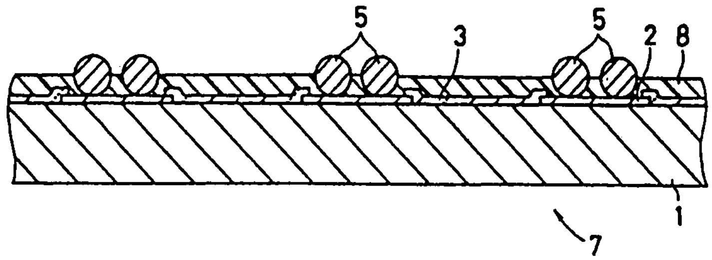

Figure 1

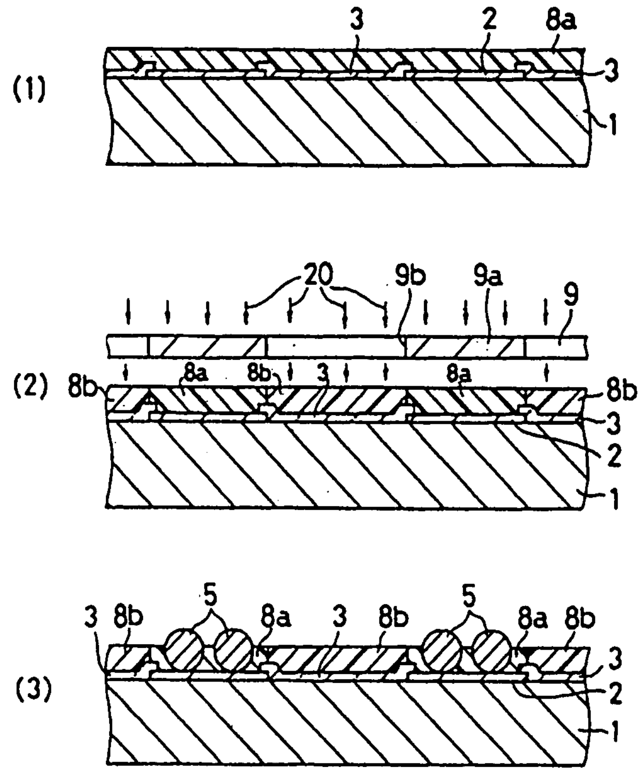

Figure 2

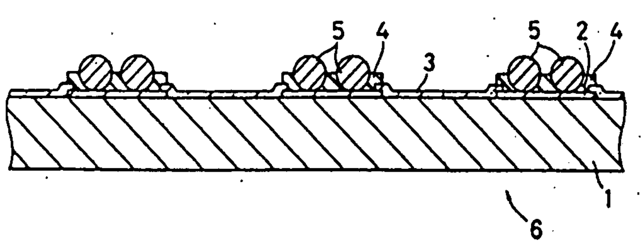

Figure 3

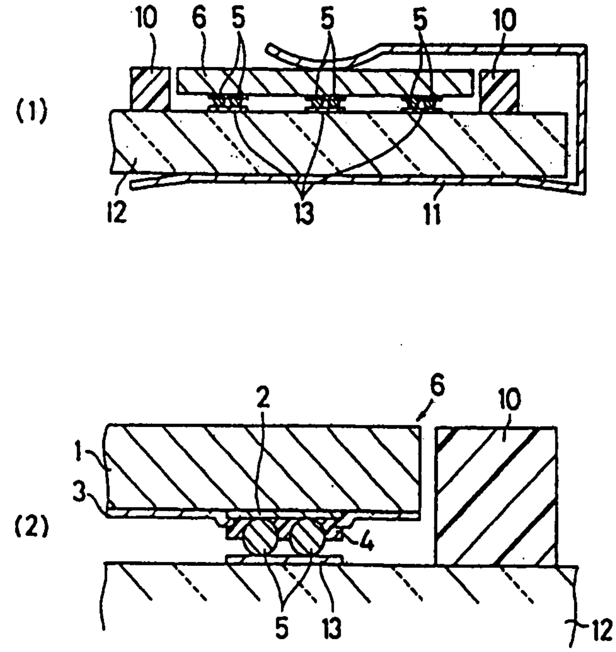

Figure 4

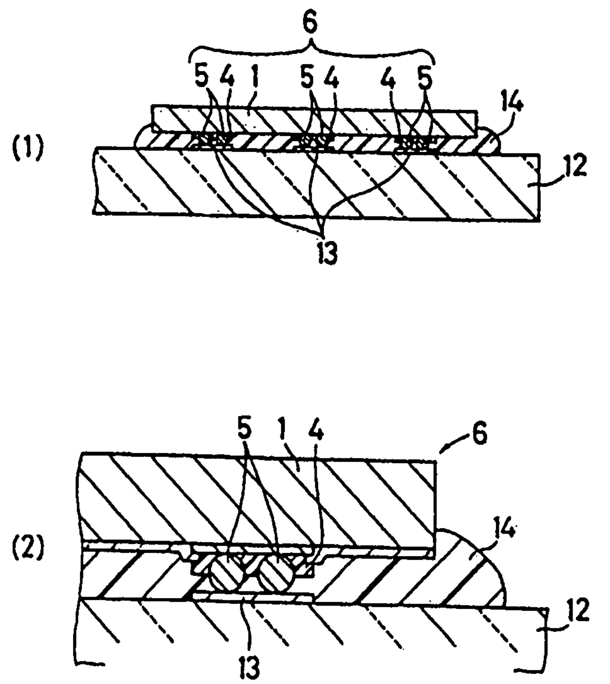

Figure 5